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A High-Speed Digital
Camera System for the Observation
of Rapid H α Fluctuations in Solar Flares

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Abstract

We have developed a prototype digital camera system for obtaining H-alpha images of solar flares with 0.1 s time resolution. We intend to operate this system in conjunction with SMM's Hard X-Ray Burst Spectrometer, with X-ray instruments which will be available on the Gamma Ray Observatory and eventually with the the Gamma Ray Imaging Device (GRID), and with the High Resolution Gamma-Ray and Hard X-Ray Spectrometer (HIREGS) which are being developed for the Max '91 program. The digital camera has recently proven to be successful as a one camera system operating in the blue wing of H-alpha during the first Max '91 campaign. Construction and procurement of a second and possibly a third camera for simultaneous observations at other wavelengths are underway as are analyses of the campaign data.

I. Instrument Development

Considerable progress has been made in the first half of 1989 with regard to the development of the High-Speed H-alpha Camera system. The system became electronically operational at Goddard in April and a decision to ship the system to Boulder for support of SMM and the first Max '91 campaign was made in Mid-may. With the Max '91 campaign beginning on June 16, the system arrived in Boulder on June 9 and was operating electronically by June 10.

The High Speed H-alpha camera system was integrated to 18-inch cassegrain telescope of the Sommers Bausch Observatory and began observations on June 15. The

weather was sufficiently good for camera operation on 14 of the 16 days of the campaign. During the campaign, the camera recorded approximately 60 gigabytes of data which translates to more than three million digital images. The absolute timing accuracy of each image is 1 millisecond.

The High-Speed Camera's coverage of the campaign activity was excellent. Obtaining observations in the blue wing of H-alpha, the camera recorded the largest flare of the campaign, an X-1.9 as measured in the 1-8 Angstrom band, as well as six M class flares and numerous C class flares. Several events were observed simultaneously with the VLA and the Owens Valley interferometers. Two flares were recorded which displayed dramatic coronal mass ejections, one of which showed prominence material beyond 1 solar radius from the limb. Additional flares exhibited rapid fluctuations in hard x-rays and point brightenings. During one M flare, we believe the camera accurately recorded the ascent of mass and the redistribution of this mass into a classic post flare loop system.

II. Planned Analyses

Although the camera was developed to study rapid fluctuations in solar flares, many of its observations during the campaign were of major flares with mass motions with high velocities. We first intend to study the tapes which recorded flares that exhibit rapid fluctuations in hard X-rays. We intend to produce optical light curves from various parts of the flare with which to compare the X-ray and microwave data. A primary objective is to discern electron time-of-flight effects. We also intend to study the impulsive phases of the larger two ribbon flares with emphasis upon the liftoff of the coronal mass ejections. Supporting radio observations from the VLA, Owens Valley, Nancay, Zurich, Berne and Brazil should be especially helpful.

III. Future Development and Observations

Goals of the next year include:

- * To operate the high speed camera as a one camera system during periods of solar flare activity until SMM falls to earth.
- * To complete and operate the camera as a two camera system with the Gamma Ray Observatory during periods of solar flare activity. The hardware for synchronizing two additional cameras is already in place. The fundamental clock for the current camera and ultimately all cameras is an oscillator that is precisely phase locked to the atomic clock in Fort Collins Colorado; thus, it is possible to synchronize the cameras so that the images obtained are precisely simultaneous.

IV. Bibliography

- "Development of a High Speed H-Alpha Camera System for the Observation of Rapid Fluctuations in Solar Flares", Kiplinger, Dennis, Orwig and Chen, Proceedings, of the First Max '91 Workshop, Kansas City, June 1988, p. 214.
- Rapid Fluctuations in Solar Flares, NASA Conference Publication 2449, Dennis, Orwig and Kiplinger eds. (Washington D. C., NASA), 1986.
- "The Relative Timing of Microwaves and Hard X-Rays in Solar Flares", Cornell, Hurford, Kiplinger and Dennis, Ap. J. Lett., 265, L99, 1984.
- "Fast Variations in High Energy X-Rays from Solar Flares and Their Constraints on Non-thermal Models.", Kiplinger, Dennis, Frost and Orwig, Ap. J. Lett., 287, L105, 1984.